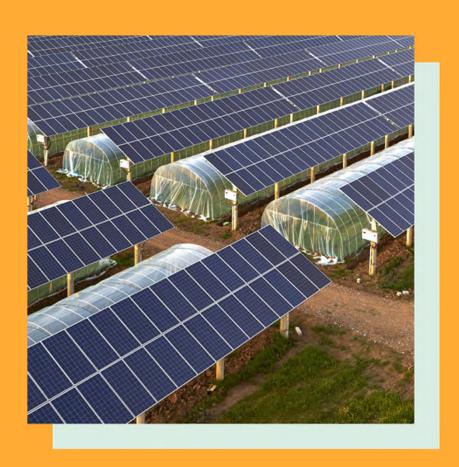
LIGHTSTAR

Farming + Solar: Agrivoltaics for Georgia



Agenda

- 1. Intros
- 2. Georgia Farmland Loss
- 3. Intro to Agrivoltaics+ Latest Research
- 4. Examples of Agrivoltaic Projects
- 5. Lightstar's Agrivoltaic Projects
- 6. FAQ's + Sources



Lightstar Agrivoltaics Team



Lucy Bullock-SiegerVP Strategy
Lightstar Renewables

- Policy and Regulatory lead for Lightstar
- Works on dual-use policy implementation in New York, New Jersey, Massachusetts, Maine, Maryland, and Illinois



lain Ward

President, Solar Agricultural Services Lightstar consultant

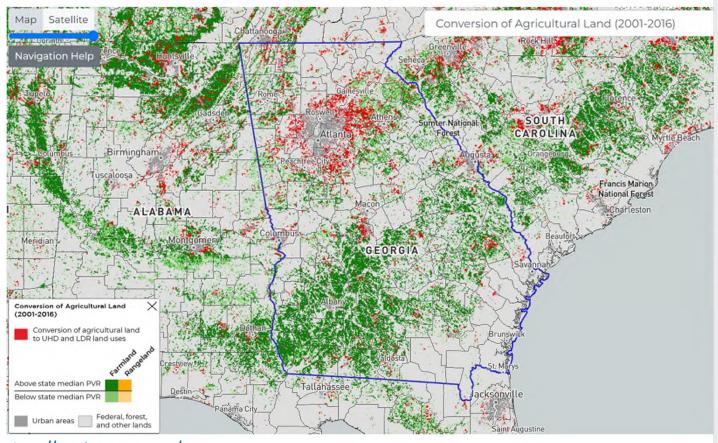
- Experience in NY, NJ, MA and ME permitting, planning and constructing dual-use projects
- NRCS Soil Conservation Planner, consultant on farm logistics planning and long-term project farmer support





Georgia Farmland Loss

Farmland Loss 2001-2016 - AFT



RELATIVE CONVERSION THREAT

Georgia scored among the top states for the conversion of

agricultural land to urban and highly developed (UHD) and lowdensity residential (LDR) uses.

RELATIVE POLICY RESPONSE

Georgia scored among the lowest states for policies and programs

that protect agricultural land from

HOW IS THIS STATE DOING?

ow Medium High CONVERSION THREAT

Georgia is in a red box because its conversion threat is higher than

its policy response, relative to other states. Learn more at www.farmland.org/

farmsunderthreat

development, promote farm viability, and facilitate the transfer

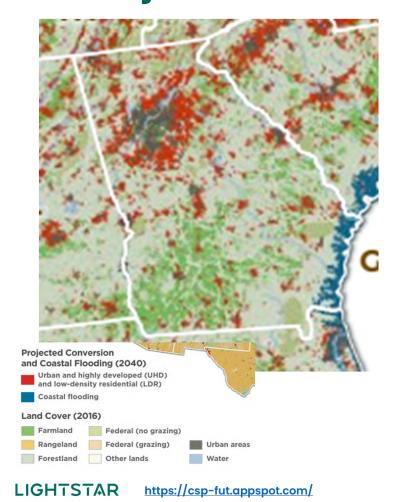
of agricultural land.

HIGH

https://csp-fut.appspot.com/



Projected Farmland Loss - 2040 - AFT



- Georgia could see up to 1,062,000 acres of permanent farmland loss by 2040. 4th biggest threat in the nation.
- Gwinnett, Cobb, Forsyth, Muscogee, and Henry counties are all within the top ten for highest percentage project farmland loss.

Percentage of Agricultural Land Projected to be Converted by 2040

County	State	Business as Usual	Runaway Sprawl	Better Built Cities
Broomfield	Colorado	67	67	53
Gwinnett	Georgia	61	61	51
Mecklenburg	North Carolina	66	72	50
Cobb	Georgia	55	55	48
Harrisonburg	Virginia	63	66	48
Forsyth	Georgia	51	51	47
Muscogee	Georgia	54	69	42
Tarrant	Texas	59	68	41
Norfolk	Massachusetts	46	48	37
Henry	Georgia	55	65	37

Projected Farmland Loss – 2040 – AFT

309,400

310,800 309,300

298,700

304,800

10,869,900

Acres	Projecte	ed to Be	Converted	by 2040

568,200

545,000

543,800

518,500

515,200

18,415,000

	Business as Usuai	Runaway Sprawi	Better Built Cities
Texas	2,192,700	2,770,100	1,375,500
rth Carolina	1,197,300	1,678,100	661,500
Tennessee	1,014,600	1,409,200	564,800
Georgia	798,400	1,062,300	474,500
California	797,400	935,300	522,100
Florida	620,200	762,500	410,400
Virginia	594,100	836,200	328,700

794,400

751,600

760,000

696,800

688,000

24,403,800

Percentage of	f Agricultural	Land Projected	to be	Converted by 2040
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	Business as Usual	Runaway Sprawl	Better Built Cities
New Jersey	16.0	20.1	10.0
Connecticut	15.8	20.9	10.3
Massachusetts	14.8	17.9	10.0
Rhode Island	14.5	17.6	9.8
Delaware	12.5	16.6	8.1
North Carolina	11.6	16.2	6.4
New Hampshire	8.3	10.0	5.2
Tennessee	8.2	11.5	4.6
Maryland	7.8	10.8	4.3
South Carolina	7.5	10.1	4.4
Florida	7.4	9.1	4.9
Virginia	7.3	10.2	4.0
Contiguous U.S.	2.0	2.6	1.1

Missouri

Alabama

Wisconsin

Ohio

Pennsylvania

Contiguous U.S.

Intro to Agrivoltaics (AgPV) + Latest Research



Why AgPV?

AgPV is the integration of agricultural or horticultural production and solar on a single parcel.

- With an additional 2,300 MW of solar in Georgia expected by 2025, local leaders and conservations organizations have concerns regarding farmland loss due to solar.
- The land is restricted to remain in agricultural production through the life of the project, often 20 years or more.
- Acceptable agricultural or horticultural activity is defined by existing statute or guidelines set by the local authority.
- Lease payments and a portion of revenue from the projects are paid directly to the farmer in the form of a quarterly stipend for the life of the project (25+ years) to ensure agricultural activity.

What Crops?

Arizona - Hardiness zone 8a

Tomatoes fruited more, and peppers **fruited 3x more** than in an open field. Additionally, dual-use grown crops were **less water stressed** than in open fields under equal water conditions, when water was decreased by 50% in the dual-use crops – there was no reduction in food production.

Illinois – Hardiness zone 5a-7b

In studying system designs – potential that in times of heavier precipitation dual-use systems could **protect plants**.

Colorado - Hardiness zone 3a-7a

First commercial dual-use project had a successful harvest – 8,600 lbs in half a season, saving on water use, and profiting from CSA. Research outcomes forthcoming.

Massachusetts - Hardiness zone 5a-7a

Conducting research since 2011 – the first dual-use project in the nation. Peppers, broccoli, kale, and swiss chard all saw the same or greater yield despite a record dry and hot summer in 2017.



Agrivoltaic Project Examples



Hayfield to Vegetable Production

- Planted July 2021, harvested 8,600 under a slightly modified singleaxis tracking array.
- Successful harvest with over 25+ varieties
- Owned operated by Jack's Solar Garden Developments

Confidential – do not distribute





Benefits

- + Reduced heat stress in cattle
- + Increased wellbeing of livestock
- + Developed by the University of Minnesota

Confidential – do not distribute

Lightstar AgPV Examples





Wappinger, NY - 2.1 MWAC, 15 acres

Thompson Family Farm

- Historically a hay field, family wants to expand production
- 2 acres of Blueberries2 acres of Strawberries6 acres of Squash
- Developed by Lightstar Renewables and construction set to begin Spring 2023



FAQs + Sources

What do we need for responsible AgPV?

- <u>Definition of AgPV</u> The technical definition of Agrivoltaics should follow the <u>Fraunhofer ISE's guidance</u>. Municipalities can use the state definition in Ag and Markets Law Sec 501 for the definition of acceptable agricultural use.
- Ensuring a project remains in production
 Developers should pay a meaningful stipend to the farmer. Utilize the tax assessment or similar for compliance. Cure periods, similar to other agricultural programs, should be allowed for projects that have fallen out of compliance due to extreme weather, crop failure, drought, and other typical agricultural challenges.
- Farm Logistics Plan should be completed in direct consultation with the farmer or farm manager, and an agricultural extension agent and/or equipped third parties (NRCS conservation planner). Should be required for site plan approval.

- Clear Construction Guidelines these may include soils being tested for Ph levels, nutrients, etc. before and after construction. Engineering, procurement and contracting firms (EPCs) must have proper soil compaction practices outlined in the specs of each project. (NY State has excellent ones)
- <u>Decommissioning of Projects</u> includes soil testing, top soil treatment, and removal of all solar system materials, unless determined that some materials would be beneficial to the farming operation.
- Agricultural Fencing should be an acceptable option for all zoning purposes and is in line with federal electric code, as it preserves the rural character of the farm and lends an added benefit to farmers by keeping wildlife away from crops.
- <u>Setbacks for Operation</u> towns should consider the total farming operation and adjusting setbacks to allow for maneuvering of necessary farm equipment, while maintaining necessary screening.

FAQ's

How can we ensure that land stays in agricultural production?

Local authorities, in states without a specific incentive program, can still ensure that a project remains in agricultural production through requiring a clause requiring annual reporting for site plan approval.

How long will it take for projects to begin growing crops?

The typical development cycle of an AgPV project is 12–18 months. The first year of crops and soil development should be considered an experimental time for both the farmer and the project, but crops can be grown as soon as the soil is prepared. Cover cropping is optional, but is helpful to mitigate compaction.

FAQ's

How do we know AgPV works?

With 3,000 MW of systems built, dual-use has been in practice for years internationally and U.S. states are starting to catch up. Studies in both Europe and Japan have established thriving dual-use farms throughout these regions. One study in Japan determined the best light conditions for various crops.** The University of Massachusetts Cranberry Station Extension conducted research that cranberry vines (among other crops) benefit from shading, even with standard solar. In Colorado, Jack's Solar Garden is establishing a body of research for solar + crops with its first harvest exceeding expectations with 8,600 lbs harvested in the first half of the 2021 harvest. In Massachusetts, dual-use projects will be online and planting in Spring 2022. The Department of Energy has been researching dual-use solar for the last 6 years and has been encouraging states to adopt programs, most recently through the Foundational Agrivoltaics Research at Megawatt Scale (FARMS) grant program.

What happens to the soil? What crops can grow?

There is already a body of research describing how AgPV contributes to soil health and crop vitality. Solar panels can improve moisture retention in soil and plants in times of high hear and low precipitation. In turn, vegetables such as potatoes, celery kale, and others increase their yields over time.* Another study showed that solar panels increase pasture grass biomass under arrays during summer months, as compared to full-sun areas.**

Studies out of Arizona have shown increased yields for tomatoes planted in dual-use arrays, minimizing heat stress.

How can we protect critical farmland with AgPV? Through construction? Decommissioning?

Detailed construction requirements for dual-use arrays should be enacted by the committee overseeing development of rules for these projects. NY and ME have published robust construction requirements for siting on agricultural soils. Decommissioning bonds are commonplace and can be required by municipalities to ensure that farmland soil health is left as it was or better. Soil testing should be required before and during construction and at the end of the system's life. Developers work with farmers and communities to creatively screen projects and preserve the rural viewshed. This is done in a way that works with the local natural landscape.

Sources

*Arenas-Corraliza et al., 2019. <u>Wheat and barely can increase grain yield in shade through acclimation of physiological and morphological traits in Mediterranean conditions</u>

**Tazawa, 1999. Effects of Various Radiant Sources on Plant Growth

*** UMass Extension, 2019. Expectations for Cranberry Growth and Productivity under Photovoltaic Panels

*Fraunhofer Institute for Solar Energy Systems, 2018. <u>Agrophotovoltaics: High Harvesting Yield in Hot Summer of 2018</u>

** Adeh, Selker, & Higgins, 2018. <u>Remarkable agrivoltaic influence on soil moisture, micrometeorology, and water-use efficiency.</u>

Barron-Gafford et. al., Nature 2019 Agrivoltaics provide mutual benefits across the food-energy-water nexus in drylands

Outline of 2020-2021 Research Findings By Professor Greg Barron-Gafford, Arizona State University

<u>Laub et. al. Agronomy for Sustainable Development 2022, Contrasting yield responses at varying levels of shade suggest different suitability of crops for dual land-use systems: a meta-analysis</u>

<u>Growing Crops Under Solar Panels? Now There's a Bright Idea</u>

<u>American Farmland Trust Dual-Use Resources</u>

Agrivoltaic Research and Resource Clearinghouse

NREL 5 C's of Agrivoltaic Development

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25